

FORM PCT/US390 REV. 5-93		US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEYS DOCKET NUMBER P99,1690
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S.APPLICATION NO. (if known, see 37 CFR 1.5) 09/381839	
INTERNATIONAL APPLICATION NO. PCT/DE98/00707	INTERNATIONAL FILING DATE March 10, 1998	PRIORITY DATE CLAIMED March 26, 1997	
TITLE OF INVENTION METHOD FOR THREE-DIMENSIONAL IDENTIFICATION OF OBJECTS			
APPLICANT(S) FOR DO/EO/US GÜNTER DOEMENS, PETER RUMMEL and RICHARD SCHNEIDER			
<p>Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:</p> <p>1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay. 4. <input type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</p> <p>5. <input checked="" type="checkbox"/> A copy of International Application (35 U.S.C. 371(c)(2)) a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US)</p> <p>6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</p> <p>7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3)) a. <input checked="" type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> have been transmitted by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input type="checkbox"/> have not been made and will not be made.</p> <p>8. <input checked="" type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)) (attached at back of English translation of application).</p> <p>9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</p> <p>10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</p> <p>Items 11. to 16. below concern other document(s) or information included:</p> <p>11. <input type="checkbox"/> An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; (PTO 1449, Prior Art, Search Report).</p> <p>12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. (SEE ATTACHED ENVELOPE)</p> <p>13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</p> <p>14. <input type="checkbox"/> A substitute specification.</p> <p>15. <input type="checkbox"/> A change of power of attorney and/or address letter.</p> <p>16. <input checked="" type="checkbox"/> Other items or information: a. <input checked="" type="checkbox"/> Submission of Drawings b. <input checked="" type="checkbox"/> Request for Approval of Drawing Changes c. <input type="checkbox"/> Letter Under Rule Under 37 C.F.R. §1.41(c) d. <input checked="" type="checkbox"/> EXPRESS MAIL #EL412789825US</p>			

17. The following fees are submitted:

BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):

Search Report has been prepared by the EPO or JPO \$840.00

International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) ... \$760.00

No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2)) \$450.00

Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO \$1,250.00

International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$ 98.00

ENTER APPROPRIATE BASIC FEE AMOUNT =

\$ 840.00

Surcharge of \$130.00 for furnishing the oath or declaration later than 20 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).

\$

Claims	Number Filed	Number Extra	Rate		
Total Claims	3	- 20 =	X \$ 22.00	\$	
Independent Claims	1	- 3 =	X \$ 82.00	\$	
Multiple Dependent Claims			\$270.00 +	\$	
TOTAL OF ABOVE CALCULATIONS =				\$ 840.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)				\$	
SUBTOTAL =				\$ 840.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). \$40.00 per property				+ SEE ATTACHED ENVELOPE	
TOTAL FEES ENCLOSED =				\$ 840.00	
				Amount to be refunded	\$
				charged	\$

a. A check in the amount of \$ 840.00 to cover the above fees is enclosed.
 b. Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.
 c. The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 08-2290. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Steven H. Noll
SIGNATURE

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NAME

28,982

Registration Number

BOX PCT

IN THE UNITED STATES DESIGNATED/ELECTED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

5

REQUEST FOR APPROVAL OF DRAWING CHANGES

APPLICANT(S): Günter Doemens et al.
ATTORNEY DOCKET NO.: P99,1690
INTERNATIONAL APPLICATION NO.: PCT/DE98/00707
INTERNATIONAL FILING DATE: 10 March 1998
INVENTION: "METHOD FOR THREE-DIMENSIONAL IDENTIFICATION OF
OBJECTS"

Assistant Commissioner for Patents
Washington, D.C. 20231

SIR:

Applicants herewith request approval of the drawing changes in FIGs 1 and 2
as shown on the drawing copies marked in red attached hereto.

Submitted by,

Steven H. Noll (Reg. 28,982)

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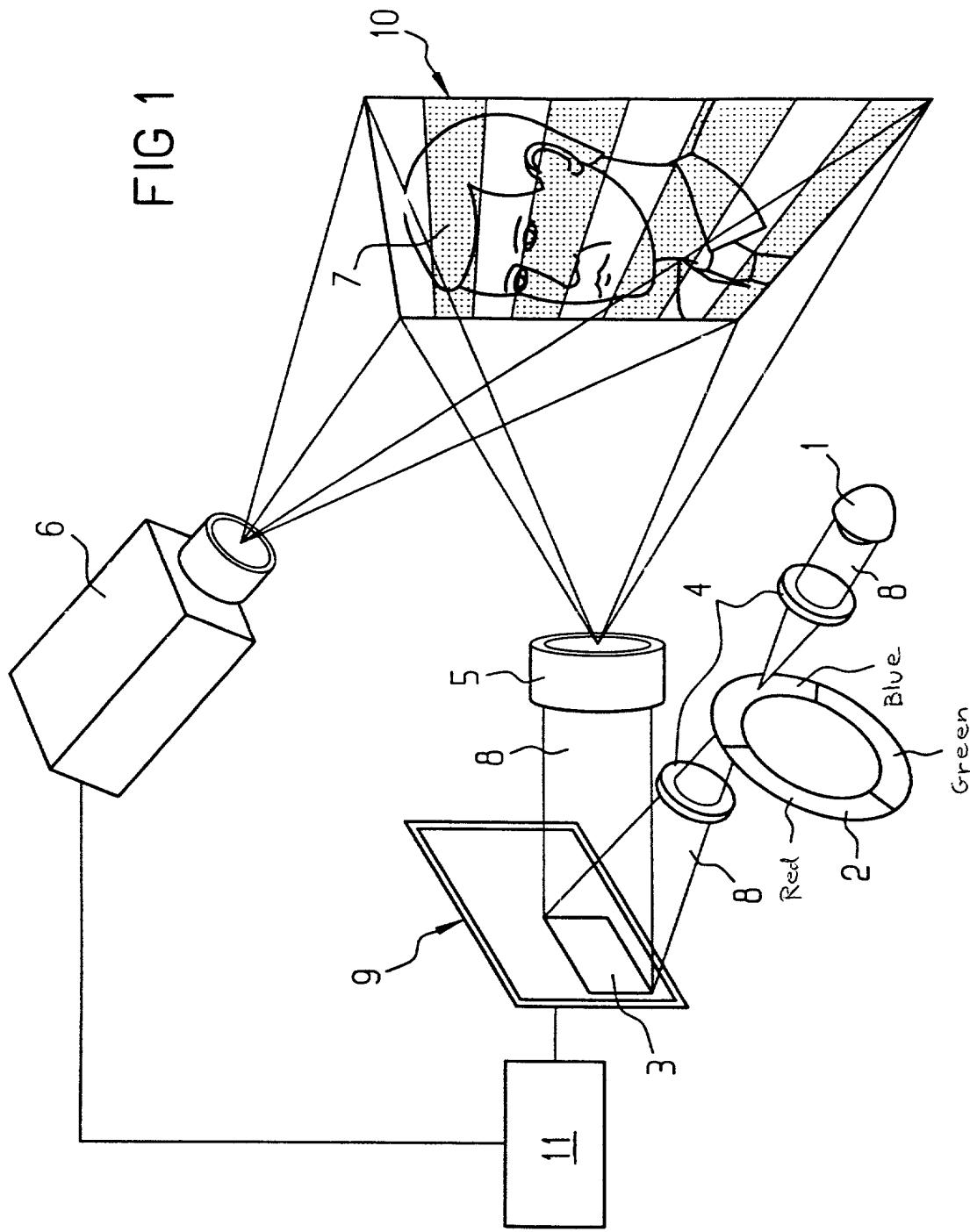
Attorneys for Applicant(s)

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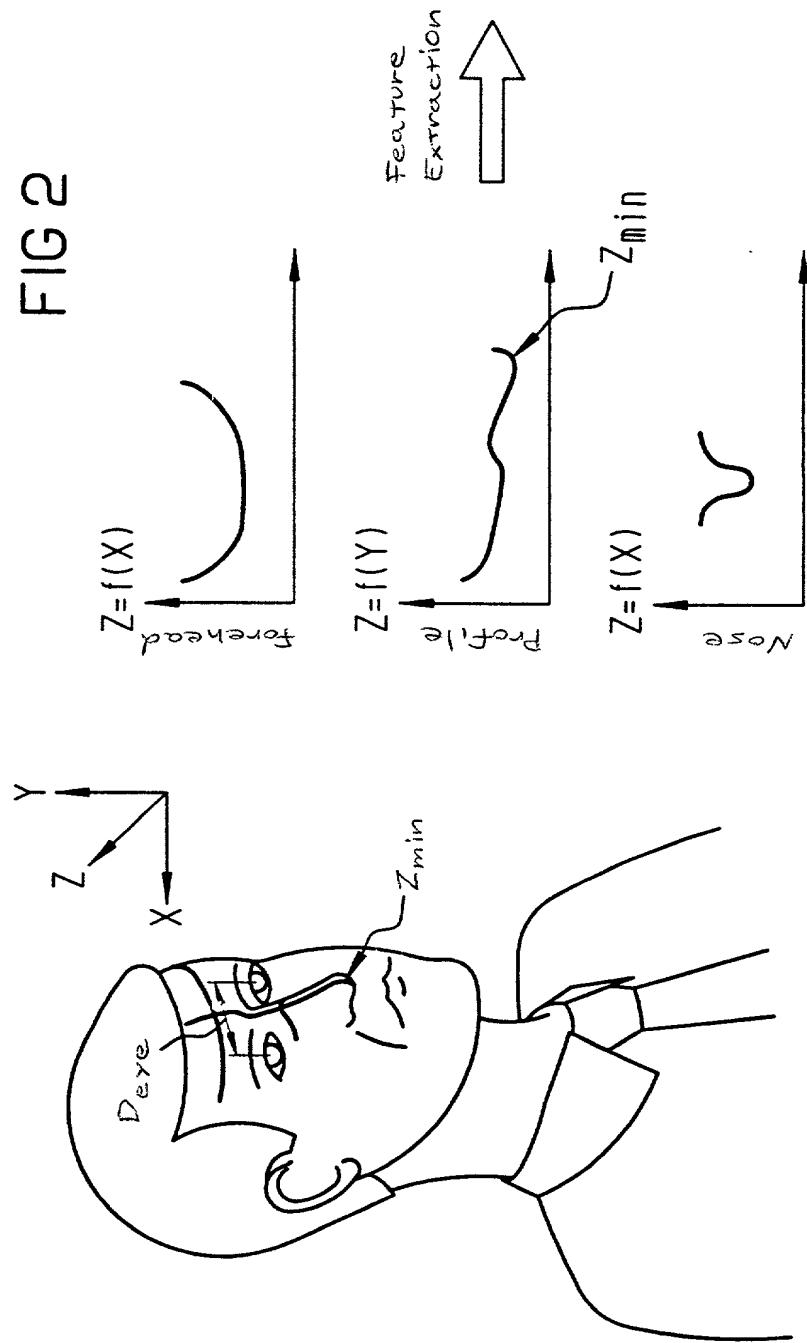
1/2

FIG 1



2/2

FIG 2



-1-

BOX PCT

IN THE UNITED STATES DESIGNATED/ELECTED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

5

AMENDMENT "A" PRIOR TO ACTION

APPLICANT(S): Günter Doemens et al.

ATTORNEY DOCKET NO.: P99,1690

INTERNATIONAL APPLICATION NO.: PCT/DE98/00707

INTERNATIONAL FILING DATE: 10 March 1998

10 INVENTION: "METHOD FOR THREE-DIMENSIONAL
IDENTIFICATION OF OBJECTS"

Assistant Commissioner for Patents

Washington, D.C. 20231

Sir:

15 Applicants herewith amend the above-referenced PCT application,
and request entry of the Amendment prior to examination on the United
States National Examination Phase.

IN THE DRAWINGS:

20 Please amend FIGs 1 and 2, as shown on the drawing copies
marked in red, attached to the Request for Approval of Drawing Changes,
filed simultaneously herewith.

IN THE SPECIFICATION:

On page 1, cancel the title above line 3, and insert the following
above line 3:

25 --TITLE

METHOD FOR THREE-DIMENSIONAL IDENTIFICATION OF OBJECTS

BACKGROUND OF THE INVENTION--;

in line 3, after "The" insert --present--;

in line 5, cancel "an", and cancel "or,";
in line 6, cancel "respectively,", and cancel "an", and cancel
"automats" substitute --automated teller machines-- therefor;
in line 9, cancel "automatic" substitute --automated-- therefor, and
cancel "plurality" substitute --number-- therefor, and cancel
"is" substitute --are-- therefor;

5 in line 12, cancel "card is to be cited here," substitute --card, which
is cited herein, stores-- therefor, and cancel "being", and
after "owner" insert a period;

10 in line 13, cancel "capable of being stored thereon.,";
in line 15, preceding "PIN" cancel "the" substitute --a-- therefor;
in line 16, cancel "face" substitute --facial-- therefor;
in line 17, cancel "This is thereby" substitute --These are-- therefor,
and cancel "a matter of";

15 in line 18, preceding "eye" cancel "the", and after "spacing," cancel
"the";
in line 19, cancel "access";
in line 30, preceding "the object" insert --which is--.

20 On page 2, in line 3, cancel "measuring" substitute --measurement-
- therefor, and after "patterns" insert --, which--;
in line 5, cancel "at the objects" substitute --on the object-- therefor,
and after "scene" insert a comma;

25 in line 6, cancel "differing" substitute --different-- therefor;
in line 7, cancel "position" substitute --positions-- therefor;
in line 13, after "for" cancel "a";
in line 16, cancel "the company publication of Texas Instruments",
cancel line 17;

30 in line 18, preceding "Digital" insert --"--;
in line 19, cancel "Ddigital" substitute --Digital-- therefor;
in line 23, cancel "plurality" substitute --number-- therefor;

in line 25, cancel "plurality" substitute --number-- therefor;
in line 27, cancel "a";
in line 28, cancel ", respectively," and cancel "are" substitute --is--
therefor.

5 On page 3, in line 2, cancel "plurality" substitute --number--
therefor;

below line 4, insert a centered heading:

--SUMMARY OF THE INVENTION--

in line 5, after "The" insert --present--;

10 cancel line 9, substitute the following therefor:

--This object is achieved in accordance with the invention in a
method for three-dimensional identification of an object
having an object surface. A digital micro mirror arrangement
is illuminated via a light source. A number of encoded

15 illumination patterns are successively projected in a beam
path through a variable color filter and onto the object
surface by driving the digital micro mirror arrangement to
sequentially illuminate the object surface with at least three
colors for identification of at least three depth planes of the
object in a single image. The image of the object is

20 registered with a color camera from a direction different from
the beam path. A high precision topography of the object
surface is calculated from the registration in a control and
evaluation unit.--;cancel line 10;

25 in line 11, cancel "the evaluation of the" substitute --evaluating--
therefor, and after "images," cancel "the evaluation"
substitute --the present invention evaluates-- therefor;

in line 12, cancel "of", and cancel "can be utilized according to the
invention, this" substitute --, which-- therefor;

30 in line 13, cancel "containing" substitute --contain-- therefor;

in line 14, cancel "a" substitute --higher-- therefor, and cancel "that
is higher by";
in line 15, cancel "factors", and cancel "plurality" substitute --
number-- therefor;
5 in line 16, cancel "can then be" substitute --are-- therefor.

On page 4, in line 2, cancel "plurality" substitute --number--
therefor;
in line 3, cancel "is in the position to apply" substitute --applies--
therefor;
10 in line 6, cancel "plurality" substitute --number-- therefor;
in line 8, cancel "umproblematical" substitute --unproblematic--
therefor;
in line 10, cancel "already";
in line 16, cancel "recognizing face" substitute --face recognition--
15 therefor;
in line 17, cancel "components of consumer electronics" substitute -
-consumer electronics components-- therefor;
in line 18, after "The" insert --present--;
cancel lines 25-26, insert the following below line 24:
20 --These and other features of the invention(s) will become clearer
with reference to the following detailed description of the presently
preferred embodiments and accompanied drawings.

DESCRIPTION OF THE DRAWINGS--;
in line 27, cancel "shows" substitute --is-- therefor;
25 in line 28, cancel the semicolon substitute a period therefor;
in line 29, cancel "shows" substitute --are-- therefor.

On page 5, above line 1, insert a centered heading:

**DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED
EMBODIMENTS--;**

in line 1, cancel "The" substitute --A-- therefor;

in line 2, cancel "the" substitute --a-- therefor;

in line 3, preceding "light" cancel "the" substitute --a-- therefor, and
cancel "objects" substitute --object-- therefor;

5 in line 4, preceding "invention" insert --present--, and cancel "an"
substitute --the-- therefor, and cancel "is present here that";

in line 7, after "by" cancel "a";

in line 10, after "into" cancel "a", and cancel "area" substitute --
areas-- therefor, and cancel "A color" substitute --Color--

10 therefor, and cancel "The" substitute --a-- therefor;

in line 11, cancel "processing 9 is composed of" substitute --
processor 9 comprises-- therefor, and cancel "arrangements
[sic]" substitute --arrangement-- therefor;

in line 12, after "arrangement" insert --3--;

15 in line 13, cancel "The" substitute --A-- therefor;

in line 14, cancel "processing" substitute --processor-- therefor, and
after "with" cancel "the" substitute --a-- therefor;

in line 15, after "of" cancel "the", and after "by" cancel "the"
substitute --a-- therefor;

20 in line 19, after "illumination" insert --10--;

in line 20, cancel "mirror device" substitute --micro mirror
arrangement 3-- therefor, and after "evaluation" insert --
such--;

in line 27, after "encoding" insert --10--.

25 On page 6, in line 1, after "of" cancel "a" substitute --the-- therefor;

in line 6, cancel "characteristic" substitute --characteristics--
therefor;

in line 12, cancel ", respectively.", and after "face" cancel "in"
substitute --at-- therefor;

30 below line 18, insert the following paragraph:

-- Although modifications and changes may be suggested by those of ordinary skill in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.--.

5 **IN THE CLAIMS:**

Please cancel claims 1-3 and substitute the following claims 4-6 therefor:

1. A method for three-dimensional identification of an object having an object surface, said method comprising the steps of:
 - 10 illuminating a digital micro mirror arrangement via a light source; successively projecting a number of encoded illumination patterns in a beam path through a variable color filter onto said object surface by driving said digital micro mirror arrangement to sequentially illuminate said object surface with at least three colors for identification of at least three depth planes of said object in a single image;
 - 15 registering said image of said object with a color camera from a direction different from said beam path; and calculating a high precision topography of said object surface from
 - 20 said registration in a control and evaluation unit.
2. The method according to claim 1, wherein said encoded illumination patterns comprise a stripe pattern having successively varied periodicity.
- 25 3. The method according to claim 1, wherein said method is used for face identification.

IN THE ABSTRACT:

On page 8, in line 1, cancel "**Abstract**" substitute the following

centered heading therefor:

--ABSTRACT OF THE DISCLOSURE--

cancel lines 2-12, substitute the following abstract therefor:

-- Known security systems that, for example, detect and check
5 features of the face for access authorization have been previously based
on an evaluation of a two-dimensional gray-scale image. The present
method provides a decisive enhancement of recognition dependability by
additional acquisition and interpretation of a three-dimensional shape of
the face. In order to nonetheless be able to implement a registration of
10 the information in a short time and so that the costs of the recognition
system are not significantly increased, an encoded illumination is
implemented with a digital micro mirror arrangement in different colors,
and the topography of the face is identified via color image processing.--

REMARKS:

15 The present Amendment revises the specification, drawings and
claims to conform to United States patent practice, before examination of
the present PCT application in the United States National Examination
Phase. All of the changes are editorial and no new matter is added
thereby. The cancellation of claims 1-3, in favor of new claims 4-6, has
20 been made solely for convenience, since the amount of bracketing and
underlining necessary to editorially amend claims 1-3 in order to conform
to United States patent practice would have been excessive and
burdensome. The cancellation of claims 1-3 is therefore not intended to
be a surrender of any of the subject matter of those claims.

Early examination on the merits is respectfully requested.

Respectfully submitted,

Steven H. Noll

(Reg. No. 28,982)

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Attorneys for Applicant(s)

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METHOD FOR THREE-DIMENSIONAL IDENTIFICATION OF OBJECTS

The invention is directed to a method for fast three-dimensional identification of objects, particularly for identifying faces. Such methods can be 5 utilized in checking an access authorization for specific rooms or buildings or, respectively, for an access authorization for specific automats.

There is an increasing need for extremely secure monitoring systems in conjunction with access authorization to specific things such as, for example, 10 automatic teller machines. A plurality of person-specific features is thereby checked. The recognition of the face is thereby accorded a significant part.

Various security systems are already in field trials. For example, the check or chip card is to be cited here, a number of features of the face of the owner being capable of being stored thereon. A user only receives access when, for example, 15 a coding number as well as features of the face recognized by the automatic unit coincide with stored data. The coding number is, for example, the PIN (personal identification number). The face features are extracted from a gray-scale image registered by a video camera. This is thereby essentially a matter of simple geometrical identifiers in one plane such as, for example, the eye spacing, the spacing between mouth and eye access, etc. Despite the relatively indefinite 20 relationship between a two-dimensional gray-scale image and the actual shape of the face, which is essentially clearly three-dimensionally expressed, extremely good results can already be achieved with known evaluation methods such as, for example, with neural networks. The recognition dependability hitherto lay at approximately 98%. A critical disadvantage of the previous methods is that these 25 can be fooled relatively easily such as, for example, with a photograph held in front of the face.

For three-dimensional object recognition, it is known to employ the principle of encoded light application in conjunction with triangulation. The critical feature of this measuring principle lies in the space-time encoding of the 30 work space to be measured, the object surface. The work space is illuminated by a chronologically successive projection of, for example, stripe patterns (gray-

5 encoded stripe patterns). The stripe patterns thereby enable the distinction of different projection directions that are characterized by a characteristic light-dark sequence. For three-dimensional measuring of an object scene, the patterns generated with the assistance of a transparent LCD (liquid crystal device) and deformed at the objects of the scene are observed by a camera from a direction differing from the illumination direction.

10 Given known position between camera, projector and object scene, the three-dimensional coordinates of the observed scene can be calculated by triangulation in a conventional way.

15 The previously known employment of transparent LCDs as light-modulating, optionally transparent elements involves a comparatively long acquisition time since the LCDs exhibit very long switching times. This approach is unsuitable for a fast acquisition (for example, 0.1 seconds for a personal identification).

20 A rapidly switchable light modulation element that, moreover, can be versatiley driven is known from the company publication of Texas Instruments cited below:

25 Larry J. Hornbeck, Digital Light Processing and MEMs: Timely Convergence For A Bright Future, Texas Instruments Ddigital Imaging Components, Dallas/Texas 75265, 23. - 24 Oct. 1995", Austin, Texas, USA.

30 A digital micro-mirror arrangement (DMD, Digital Micromirror Device) described therein can accomplish a digital light processing (DLP). This light-modulating element is composed of a plurality of mirrors micro-mechanically applied on an integrated circuit (chip), these being drivable individually or in groups. The plurality of mirrors can amount to up to 48,000 per chip. Normally, a DMD chip can be driven with an 8-bit word, as a result whereof 256 gray scale steps derive. Since this light-modulating element is initially used for a television or, respectively, video applications, further data are correspondingly based on video-technical devices. A critical feature, however, is comprised therein that the switching times lie in the range of microseconds. The reproduction of a television image is thus enabled by employing, for example, a three-color illumination of the

chip, whereby the DMD chip is correspondingly electronically driven. The image presented by the plurality of correspondingly driven mirrors can be projected onto a screen. An optical element of the described type can thus generate a high resolution and a very good contrast.

5 The invention is based on the object of acquiring the topography of three-dimensional objects by encoded illumination and with television picture processing significantly faster without thereby significantly increasing the system costs.

10 This object is achieved by the features of claim 1.

15 Advantageous developments can be derived from the subclaims.

20 In addition to the evaluation of the two-dimensional images, the evaluation of three-dimensional face shapes can be utilized according to the invention, this containing significantly more extensive and more dependable information. The advantages resulting therefrom lie in a recognition dependability that is higher by factors, as a result whereof a considerably greater plurality of persons can be identified. Contours or sections in different planes can then be utilized as features for recognizing a three-dimensional surface. A basic prerequisite for a fast recognition with extremely high recognition dependability is the complete and correct acquisition of the surface topography. Triangulation in conjunction with an encoded illumination is available as a method. Given the known gray code illumination, a stripe pattern is projected onto the object, the periodicity thereof being varied. For example, the numbers of lines are doubled. Given n different periodicities that are registered in n images, two super n depth planes are obtained given this method. Accordingly, at least six different encoded images are required for 64 depth planes. This method requires a fast switching of the illumination images since the recognition procedure given a real face registration must be ended in a very short time because a person generally does not stand still for very long. The liquid crystal modulators currently available for this purpose require a time span of approximately 0.1 seconds for the information registration for three-dimensional acquisition. New possibilities are opened up in this approach by the substitution of the liquid crystal modulator. This is inventively achieved by a

micro mirror modulator (DMD, Digital Micromirror Device, DMD microchip). This element, which is composed of a plurality of switchable micro mirrors that can be individually driven, is in the position to apply an encoded illumination onto a three-dimensional surface, whereby different illumination patterns can be generated with high resolution and high contrast. Over and above this, this can occur with adequately high switching frequency, so that a plurality of images can be sequentially acquired in a short time for light encoding methods.

Over and above this, the invention also enables the unproblematical utilization of an encoded illumination with different colors, so that three depth planes can be simultaneously already acquired with one television frame. The evaluation of the three color channels of red, green and blue of a color camera is thereby used.

The combination of encoded illumination, the digital micro mirror system, as well as color image processing ideally supplies the fast acquisition and high recognition dependability for the recognition of three-dimensional objects, for example for recognizing face. A face identification system of this type can be realized of cost-beneficial components of consumer electronics.

The invention enables the introduction of directly acquired three-dimensional data of the human face for personal identification. In general, a method for fast, high-resolution and cost-beneficial acquisition of the three-dimensional data of a human face is made available, whereby the combination of an encoded illumination with a digital micro mirror element is utilized. The color image processing can be optionally added and reduces the acquisition time to one-third.

Exemplary embodiments are described below with reference to schematic figures.

Figure 1 shows a schematic arrangement of component parts for three-dimensional face recognition with digital light and color-image processing;

Figure 2 shows examples of the three-dimensional face recognition on the basis of geometrical data.

The right-hand image half of an object surface 7 can be seen in Figure 1. Theoretically, the digital micro mirror arrangement 3, which is illuminated with the light source 1, can generate an arbitrary image at the location of the objects 7. For the purpose of the invention, however, an object 7 is present here that is correspondingly radiated with encoded illumination, so that an encoding 10 appears on the object 7. The beam path emanating from the light source 1 is respectively suitably formed preceding and following a color filter 2 by a respective optics 4. The color filter 2 is composed of a rotating disk that comprises a chromatic, light-permeable strip at the circumference that is uniformly divided 15 into a red, green and blue area. A color image processing is thus enabled. The digital light processing 9 is composed of a digital micro mirror arrangements [sic] 3. This arrangement is what is referred to as a DMD chip (digital micro mirror arrangement, digital miro mirror device). The camera 6 is controlled in addition to the light processing 9 with the control and evaluation unit 11. The projection of the light ensues behind the digital micro mirror arrangement 3 by the projection lens 5 onto the object surface 7. The corresponding light encoding has thereby been applied by the digital micro mirror arrangement 3. The camera 6 must be a color picture camera for a color picture evaluation.

An encoded illumination is first projected such onto the object 7 via the 20 digital mirror device in the color image evaluation that three striped patterns with respectively different color (for example, red, green, blue) and periodicity are simultaneously present in a video frame. Due to the separate and parallel registration of the three different color patterns, the information for calculating three depth planes can thus be acquired in a video frame. In order, for example, 25 to assure the evaluation of a face surface within 0.1 seconds with extremely high recognition dependability, this face is illuminated with an encoded, in this case stripe-like encoding, whereby the stripes exhibit different periodicities in successive images. The face is thereby acquired, for example, by 200 x 200 x 150 picture elements having a spatial resolution of 2 x 2 x 2 mm. The underlying 30 principle of the height measurement at the object 7 is, for example, triangulation. The previous problem of a fast switching of the illumination images for the stripe-

shaped encoding 10 is solved with the employment of a digital micro mirror arrangement 3. The time span for the complete and dependable acquisition of an object 7 such as, for example, a face can thus occur in approximately 0.1 seconds. Approximately 1 seconds was previously required.

Three characteristics of a face are shown by way of example in Figure 2, these being either characteristic for the face by themselves or from which even more detailed features are derived. On the basis of these and similar recognition features, faces can be distinguished with higher dependability than with two-dimensional methods currently utilized.

Figure 2 shows three possibilities of definitions of specific characteristics of a face on the basis of the spatial coordinates x, y and z. The upper diagram shows a line or, respectively, contour of the face in the brow region in a plane lying perpendicular to the y-axis. The same is true of the lower diagram in Figure 2, whereby the nose area is involved here. The middle of the three-diagrams in Figure 2 represents a line that is located in a plane perpendicular to the x-axis. Accordingly, a lateral profile of the face is reproduced here. The mark Z_{\min} thereby indicates, for example, the position of the tip of the nose relative to the face profile.

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Patent Claims

1. Method for three-dimensional identification of objects (7), whereby
 - a digital micro mirror arrangement (3) is illuminated by a light source (1);
 - the digital micro mirror arrangement (3) is driven such that a plurality of encoded illumination patterns are successively projected onto the object surface (7), and, using a variable color filter in the beam path (8), the object is sequentially illuminated with at least three different colors and, thus, at least three depth planes can be identified in a single image;
 - the object (7) illuminated in this way is registered with a color camera (6) from a direction different from the illumination direction and the topography of the object (7) is calculated therefrom with high precision in a control and evaluation unit (11).
- 10 2. Method according to one of the preceding claims [sic], whereby the encoding is composed of a stripe pattern whose periodicity is successively varied.
- 15 3. Method according to one of the preceding claims that is used for face identification.

Abstract

Method for Three-Dimensional Identification of Objects

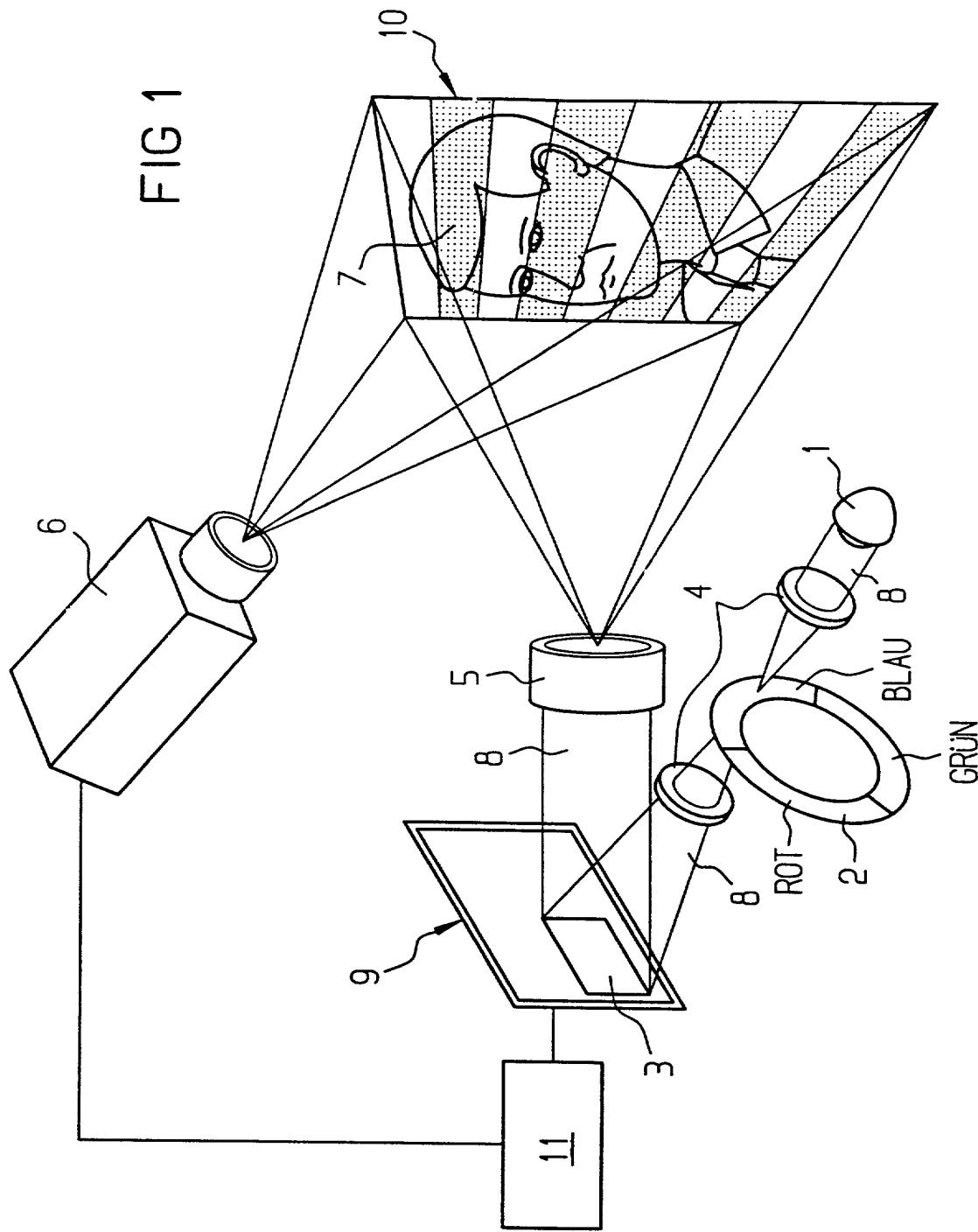
Known security systems that, for example, detect and check features of the face for an access authorization have been previously based on the evaluation of the two-dimensional gray-scale image. A decisive enhancement of the recognition dependability is supplied by the additional acquisition and interpretation of the three-dimensional shape of the face. In order to nonetheless be able to implement the registration of the information in a short time and so that the costs of the recognition system are not significantly increased, an encoded illumination is implemented with a digital micro mirror arrangement in different colors, and the topography of the face is identified via a color picture processing.

Figure 1

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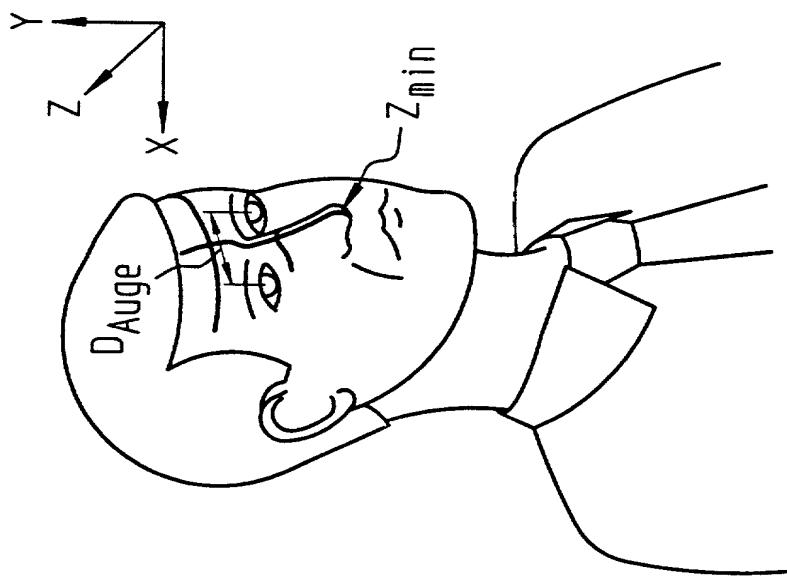
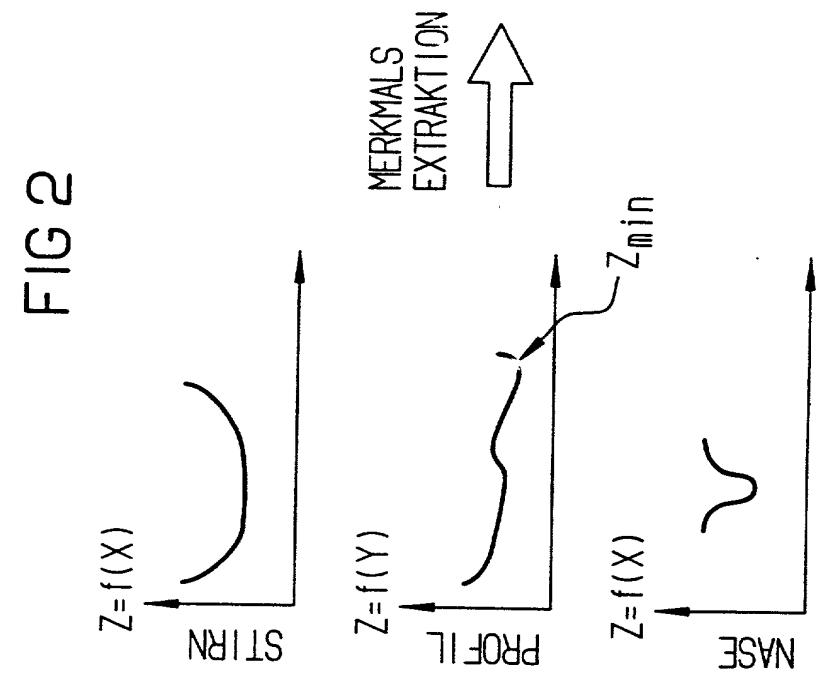
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FIG 1



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FIG 2



Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
 German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Verfahren zur dreidimensionalen Identifizierung von Objekten

deren Beschreibung

(zutreffendes ankreuzen)

hier beigefügt ist.

am _____ als

PCT internationale Anmeldung

PCT Anmeldungsnummer _____

eingereicht wurde und am _____

abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmelde datum haben, das vor dem Anmelde datum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

the specification of which

(check one)

is attached hereto

was filed on _____ as

PCT international application

PCT Application No. _____

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

197 12 844.0 Germany 26. März 1997
(Number) (Country) (Day Month Year Filed)
(Nummer) (Land) (Tag Monat Jahr eingereicht)

Yes
 No
Ja Nein

(Number) (Country) (Day Month Year Filed)
(Nummer) (Land) (Tag Monat Jahr eingereicht)

Yes
 No
Ja Nein

(Number) (Country) (Day Month Year Filed)
(Nummer) (Land) (Tag Monat Jahr eingereicht)

Yes
 No
Ja Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date)
(Anmeldedatum)

(Status)
(patentiert, anhängig,
aufgegeben)

(Status)
(patented, pending,
abandoned)

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date)
(Anmeldedatum)

(Status)
(patentiert, anhängig,
aufgegeben)

(Status)
(patented, pending,
abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozeßordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden können, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: (Name und Registrationsnummer anführen)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

19
 Messrs. John D. Simpson (Registration No. 19,842) Lewis T. Steadman (17,074), William C. Stueber (16,453), P. Phillips Connor (19,259), Dennis A. Gross (24,410), Marvin Moody (16,549), Steven H. Noll (28,982), Brett A. Valiquet (27,841), Thomas I. Ross (29,275), Kevin W. Guynn (29,927), Edward A. Lehmann (22,312), James D. Hobart (24,149), Robert M. Barrett (30,142), James Van Santen (16,584), J. Arthur Gross (13,615), Richard J. Schwarz (13,472) and Melvin A. Robinson (31,870), David R. Metzger (32,919), John R. Garrett (27,888) all members of the firm of Hill, Steadman & Simpson, A Professional Corporation.

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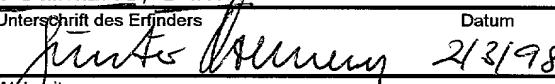
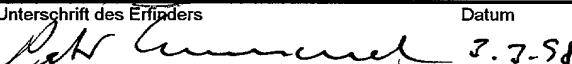
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<u>D-83703 Gmund</u>			
<u>Bundesrepublik Deutschland</u>			

20
 (Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

Voller Name des dritten Miterfinders:		Full name of third joint inventor:	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
<i>Richard Schneider</i> 10. 3. 1998			
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Unterschrift des Erfinders	Datum	Inventor's signature	Date
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Staatsangehörigkeit	Citizenship		
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Unterschrift des Erfinders	Datum	Inventor's signature	Date
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Postanschrift	Post Office Address		
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Unterschrift des Erfinders	Datum	Inventor's signature	Date
Wohnsitz	Residence		
Staatsangehörigkeit	Citizenship		
Postanschrift	Post Office Address		

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(Supply similar information and signature for third and subsequent joint inventors).